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Social and professional influences on antimicrobial prescribing for doctors-in-training: a realist review

Running title: Realist review of antimicrobial prescribing

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Abstract

Background: Antimicrobial resistance has led to widespread implementation of interventions for appropriate prescribing. However, such interventions are often adopted without an adequate understanding of the challenges facing doctors-in-training as key prescribers.

Methods: The review followed a realist, theory-driven approach to synthesising qualitative, quantitative and mixed-methods literature. Consistent with realist review quality standards, articles retrieved from electronic databases were systematically screened and analysed to elicit explanations of antimicrobial prescribing behaviours. These explanations were consolidated into a programme theory drawing on social science and learning theory, and shaped though input from patients and practitioners.

Results: By synthesising data from 131 articles, the review highlights the complex social and professional dynamics underlying antimicrobial prescribing decisions of doctors-in-training. The analysis shows how doctors-in-training often operate within challenging contexts (hierarchical relationships, powerful prescribing norms, unclear roles and responsibilities, implicit expectations about knowledge levels, uncertainty about application of knowledge in practice) where they prioritise particular responses (fear of criticism and individual responsibility, managing one's reputation and position in the team, appearing competent). These complex dynamics explain how and why doctors-in-training decide to: a) follow senior clinicians' prescribing habits, b) take (or not) into account prescribing aids, advice from other health professionals, or patient expectations, and c) ask questions or challenge decisions. This increased understanding allows for targeted tailoring, design and implementation of antimicrobial prescribing interventions.

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Conclusions: This review contributes to a better understanding of how antimicrobial prescribing interventions for doctors-in-training can be embedded more successfully in the hierarchical and inter-professional dynamics of different healthcare settings.

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Background

The impact of Anti-Microbial Resistance (AMR) is becoming increasingly clear and efforts to curtail its emergence are gaining priority at a global scale.[1-5] These efforts are driven by recognition of the projected substantial human and financial costs associated with reduced efficiency of existing antimicrobial agents. It has been estimated that by 2050 there will be 10 million deaths a year globally due to drug resistance and the total cost of lost production will come to US$100 trillion.[6]

A broad range of interventions have been implemented worldwide to improve antimicrobial stewardship.[7] In the United Kingdom (UK), such interventions include the TARGET toolkit in primary care and the 'Start Smart Then Focus' approach in secondary settings, among other initiatives.[8-16] Encouraging signs of reduction in total antimicrobial consumption have already been identified in primary and secondary care settings in England, but these improvements are insufficient to address the scale of the problem.[17]

In the United States (US), rising rates of broad-spectrum antibiotic prescribing have been recorded across age groups and overall antibiotic prescribing has risen for older patients, with a large proportion of prescriptions considered inappropriate.[18, 19] The Infectious Diseases Society of America and the Society for Healthcare Epidemiology have published guidelines for the implementation of antibiotic stewardship programmes, featuring core strategies and supplementary interventions.[20, 21] In an attempt to address current rates of low implementation,[22] all healthcare facilities are required to establish antibiotic stewardship programmes by 2017.[23]

Despite the wealth of antimicrobial stewardship programmes, it is often difficult to know how best to target resources to maximise intended outcomes. Previous systematic reviews have compared effect sizes of different intervention strategies,[24, 25] favouring restrictions in

prescribing options (e.g. compulsory order forms or expert approval) over purely educational or feedback programmes.[25] Yet, less attention has been paid to how intervention strategies work differently in different contexts and for different groups of prescribers. With social norms and informal influences increasingly recognised as important in antimicrobial prescribing,[26-28] uncertainty still exists about how to implement different types of interventions and what refinements are needed for local circumstances.

There is also less understanding of how antimicrobial prescribing interventions should be tailored to address the specific needs of doctors-in-training (i.e. medical school graduates undergoing clinical training to become specialists or general practitioners). Postgraduate trainees across all stages are classed as independent prescribers and will typically prescribe medicines, including antimicrobials, on a daily basis. In the UK they are numerically the largest prescribers in the hospital setting.[29] In many countries, they form the foundation of the medical workforce and carry out a significant proportion of core medical work, often under little supervision. Their learning and training needs are of critical importance since they are developing skills to lead clinical teams as senior practitioners in the future. Yet, most antimicrobial prescribing interventions target both junior and senior doctors as a uniform body of health professionals assuming they have similar needs and operate under the same circumstances.[30]

To account for the context in which antimicrobial prescribing decisions are made and the significant challenges encountered by doctors-in-training at different levels, we followed a realist approach for evidence synthesis.

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Methods

A realist review is particularly relevant to complex interventions characterised by significant levels of heterogeneity. This is because it follows an interpretive, theory-driven approach to synthesising evidence from qualitative, quantitative and mixed-methods research. Its main strength comes from providing findings that explain how and why context can influence outcomes.

Our review on IMProving Antimicrobial prescribing for doCtors-in-Training (IMPACT) was structured around the following questions:

1. What are the 'mechanisms' by which antimicrobial prescribing behaviour change interventions are believed to result in their intended outcomes?
2. What are the important 'contexts' which determine whether the different mechanisms produce intended outcomes?
3. In what circumstances are such interventions likely to be effective?

Rather than defining effectiveness in terms of effect size as in a standard systematic review, the IMPACT review examined how the responses of doctors-in-training to the resources offered to them (*mechanisms*) were triggered in particular circumstances (*contexts*) to generate certain behaviours or *outcomes* for antimicrobial prescribing (see Supplementary data – Part 1 for relevant definitions).

The review followed a detailed, published protocol[31] based on Pawson's five iterative stages: (1) Locating existing theories, (2) Searching for evidence, (3) Selecting articles, (4) Extracting and organising data, (5) Synthesising the evidence and drawing conclusions.[32] To this we have added Step (6) Writing and engaging with substantive theory, to highlight the importance of developing a narrative from realist analysis as extending beyond Context-Mechanism-Outcome Configurations (CMOCs) – see Glossary in Supplementary data Part 1 for definition

– and to foreground the role of theoretically substantiating findings (drawing on substantive theory).

The review is registered on PROSPERO (CRD42015017802) and ran for 18 months (June 2015 - November 2016). The Central University Research Ethics Committee (CUREC) at the University of Oxford granted exemption from ethical approval. This paper reports the IMPACT realist review according to the RAMESES publication standards.[33] More details are included in the full project report published on the National Institute for Health Research (NIHR) Journals Library as per standard practice for projects funded by the Health Services and Delivery Research (HS&DR) programme: https://www.journalslibrary.nihr.ac.uk/programmes/hsdr/139724/#/.

Step 1: Locating existing theories

Before any literature searching had taken place, we devised an initial programme theory as a starting point for the review, drawing on experiential, professional and content knowledge of the research team (including a primary care practitioner and GP trainer, academic experts in medical education, clinical training and implementation science). This initial programme theory acted as a guide for refining assumptions against the data in the literature.

To begin refining this initial programme theory and to identify the focus of the review, we carried out exploratory searching using keyword-, author- and project-based methods in MEDLINE/PubMed and Google Scholar (see Supplementary data – Part 2 for example keywords). We also found initial literature through citation tracking and snow-balling, searched for grey literature and elicited key studies from experts.[34] The aim was to identify a range of possible explanations about how antimicrobial prescribing interventions work for doctors-in-training at different levels, and why they may work in particular circumstances and not in

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147 others.[35, 36] Iterative programme theory building required discussions within the team to make
148 sense of, interpret and synthesise the different components.

149 A diverse stakeholder group was recruited to provide content expertise for programme theory
150 refinement. The group included patients, carers, senior consultants, doctors-in-training at
151 different stages, pharmacists, microbiologists, academics and policy-makers (n=21 in total).
152 Consultations with stakeholders took place in four two-hour meetings (including one policy
153 workshop) at regular intervals throughout the project, but also through telephone calls and
154 email exchange. Detailed notes were kept in all consultations with stakeholders to inform
155 programme theory and create a clear audit trail.

156

157 **Step 2: Searching for evidence**

158 We carried out two distinct formal literature searches, which were tested, refined and conducted
159 by an Information Specialist (SB). The search strategies were developed iteratively in
160 MEDLINE to reach appropriate sensitivity and specificity. A combination of free-text and
161 indexing terms were used. The search syntax and indexing terms used in MEDLINE were then
162 translated for use in other databases. Relevant studies identified using hand searching were
163 used to benchmark the search strategy. We also undertook forward citation chasing (using
164 Google Scholar) and manually searched citations contained in the reference lists of articles and
165 reports important for the development of programme theory. Google alerts were set up and
166 articles received from content experts were also included.

167

168 ***Main search***

169 Drawing on adaptations from a related systematic review,[30] the main search strategy used
170 combinations of search terms for the concepts 'doctors-in-training', 'prescribing', and

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'antimicrobial' (see MEDLINE main search strategy example in Supplementary data – Part 2). In September 2015 we searched the following databases: Embase, MEDLINE, MEDLINE-in-process, PsycINFO, Web of Science, CENTRAL, Cochrane Database of Systematic Reviews, HTA database and ASSIA. These databases were chosen as the most appropriate to search potentially relevant literature in this area, following the exploratory search in Step 1. We included all studies on antimicrobial prescribing behaviour or interventions that referred to doctors-in-training (any specialty and level), regardless of study design (quantitative, qualitative and mixed methods) or setting (hospital or primary care), and including all prescribing related outcome measures. We excluded studies when they focused on drug administration only (no prescribing decision).

Additional search: hierarchies, team-working and decision-making

Following analysis of the literature from the main search and discussions with the stakeholder group, an additional search was undertaken to allow the review to focus on issues emerging as significant. This additional search focused on social and professional influences in clinical training, and more specifically related to hierarchies, team-working and decision-making. It was not intended to be exhaustive, but to purposefully draw together relevant literature from a different range of disciplines and provide an explanatory backbone for the wider contextual influences identified as important from the analysis of the literature in the main search.

The additional search strategy was developed in a similar way to the main search. We used combinations of keywords for the concepts 'hierarchy', 'decision making', 'team work' and 'junior doctor' (see MEDLINE additional search strategy example in Supplementary data – Part 2). In January 2016 the following databases were searched: MEDLINE, MEDLINE-in-process, PsycINFO, CENTRAL, Cochrane Database of Systematic Reviews, HTA database

and ASSIA. Studies were included when they discussed the role of hierarchies, teamwork and decision-making, in relation to doctors-in-training (any specialty and level), regardless of study design or setting (hospital or primary care). We had no pre-specified exclusion criteria. Included studies were not necessarily linked to prescribing as we were looking to understand the wider context in which doctors-in-training practise.

The results of both searches were exported to Endnote X7 bibliographic management software (Thomson Reuters Corporation, Toronto, Ontario) and de-duplicated using automated and manual checking. All citations were reviewed by CP against the inclusion criteria and a 10% random sub-sample was reviewed independently by GW.

Step 3: Selecting articles

The selection process primarily focused on the extent to which articles included data that could contribute to the development and refinement of programme theory. CP screened all titles and abstracts in reverse chronological order (to gain a better understanding of shifts in the topics reported) and assessed whether the full text should be obtained. For those articles that met the inclusion criteria, CP retrieved the full texts and classified them into categories of high and low relevance, depending on their relevance to programme theory development (e.g. current situation in the National Health Service (NHS) and the wider UK context, or the extent to which the role of doctors-in-training was discussed). At the point of inclusion based on relevance, the trustworthiness and rigour of each study was also assessed.[36] Considerations of rigour and relevance were often interrelated, as papers were more likely to include data useful for programme theory refinement when they had followed their chosen methodology to the standard required. Again, a random 10% sample was reviewed by GW to ensure selection decisions were made consistently.

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219

220 **Step 4: Extracting and organising data**

221 Once the core dataset was established, initial manual coding was carried out chronologically
222 (from the most recent article) for familiarisation with the data. In the first rounds of analysis
223 the content was classified in broad descriptive, conceptual categories. Analysis then continued
224 in NVivo 10 (QSR International), focusing first on the richest sources, i.e. articles with most
225 potential to inform the programme theory, and then applying the coding framework to the rest
226 of the papers (deductively) and creating new codes as needed (inductively). By looking at each
227 of the conceptual categories more closely, CP and GW applied a realist logic and analysed
228 sections of texts as related to contexts and/or mechanisms for specific reported outcomes – this
229 was subsequently confirmed with the rest of the team. In doing this, we followed a realist
230 philosophy of science focusing on generative causation, to interpret and explain how different
231 groups of doctors-in-training reasoned about and responded (by way of 'hidden' mechanisms)
232 to contextual influences available in their environment to produce reported outcomes and to
233 identify the specific contexts or circumstances when these mechanisms were more likely to be
234 'triggered'. As the review progressed we iteratively refined the programme theory driven by
235 interpretations of the data in articles included in the review.

236 The characteristics of the documents were extracted into an Excel spreadsheet (see
237 Supplementary data – Part 3). A sample 10% of coded papers was independently reviewed by
238 GW for consistency. The aim of the analysis was to reach theoretical saturation, in that
239 sufficient information has been captured to explain the wide range of antimicrobial prescribing
240 experiences of doctors-in-training reported in the included articles.

241

242 **Step 5: Synthesising the evidence and drawing conclusions**

Excerpts coded under specific concepts in NVivo were exported into Word documents, to provide a more flexible space to examine the viability of different CMOCs, experiment with different formulations and work towards building the narrative of the synthesis. To develop a programme theory of the antimicrobial prescribing experiences of doctors-in-training we moved iteratively between the analysis of particular examples, stakeholder interpretations, refinement of programme theory, and further iterative searching for data in our existing dataset to refine particular subsections of the programme theory (for more details on the analysis and synthesis processes see Supplementary data – Part 4).

We continued to apply a realist logic of analysis to synthesise the data. This means that we followed a process of constantly moving from data to theory (abductive analysis defined in Supplementary data – Part 1) to refine explanations about why certain behaviours are occurring and tried to frame these explanations at a level of abstraction that could cover a range of phenomena or patterns of behaviour in different settings. This included inferences about which mechanisms may be triggered in specific contexts, as these often remained hidden or were not articulated adequately in the literature. Relationships between contexts, mechanisms and outcomes were sought not just within the same articles, but also across sources. For example, mechanisms inferred from one article could help explain the way contexts might be seen to influence outcomes in a different article.

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Step 6: Writing and engagement with substantive theory

Beyond analysis and synthesis, the writing process also helped us finalise the programme theory, as it allowed us to bring together the different CMO configurations and to create a narrative that synthesises and explains the data presented in the literature. This process also enabled us to fine-tune our interpretations, to debate the meaning and relevance of different aspects of the programme theory and to develop shared understandings of our arguments. By drawing on a range of social science and learning theories (identified in the literature reviewed or separately) we were able to substantiate the inferences made about mechanisms, contexts, outcomes and the configurations between these elements, and to enhance the plausibility and coherence of the arguments.[37-45]

Results

Search results

The process of screening and article selection resulted in 131 references. Of those, 81 references came from the main literature search and 35 references from the additional search. The remaining 15 articles resulted from citation-tracking, targeted searches and expert suggestions, on the basis of relevance to programme theory.

Of the 131 references, 78 used quantitative methods, 37 used qualitative methods, 12 were mixed methods papers, and there were also 3 position papers and 1 report. Supplementary data – Part 3 provides more details on the characteristics of the studies included in the dataset for the review.

The PRISMA diagram (see *Figure 1*) illustrates the screening and selection process.

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Figure 1: PRISMA diagram

Focus of the review

Interventions for doctors-in-training were often focussed on knowledge or skills alone, were not described in enough detail or were mainly evaluated using pre-/post- study designs. On their own, these articles did not provide enough information to adequately develop and refine an in-depth programme theory about how antimicrobial prescribing intervention components contributed to particular outcomes. Therefore, we chose to focus on explaining how antimicrobial prescribing works for trainees as a process more generally. In this way, we were able to overcome limitations of poor description and lack of comprehensive evaluations and develop findings that can be transferable across different settings. Through systematic coding and analysis of the included papers we were able to reach theoretical saturation on the concepts emerging as important for the development of programme theory on antimicrobial prescribing behaviours of doctors-in-training.

We attempted to build explanations of how and why trainees engage with antimicrobial prescribing differently under different circumstances. To do this, we focused on situations where antimicrobial prescribing decisions appear more challenging and where there is increased uncertainty about what course of action to take (compared to when decisions are clear-cut, e.g. when history, examination and investigations more clearly support a diagnosis and management plan). Instead of identifying barriers and facilitators to antimicrobial prescribing, we focused on what trainees do in the *presence* of challenges, such as diagnostic uncertainty, inexperience and lack of knowledge, to reach antimicrobial prescribing decisions.

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Programme theory and CMOCs

The following parts of the *Results* section provide a narrative overview of the programme theories on antimicrobial prescribing practices of doctors-in-training, based on the realist analysis and explanatory CMOCs developed from the literature reviewed. The narrative presents the programme theories organised under four categories: (1) influence of the medical hierarchy on prescribing decisions, (2) influence of the hierarchy on balancing conflicting priorities and using sources of support, (3) assistance seeking and challenging decisions, and (4) changing contexts. These four categories emerged following analysis and clustering of the data from the literature.

Only selected CMOCs are presented in this section due to word restrictions. Supplementary data (Part 5) includes the full list of all 28 CMOCs along with examples of data excerpts from the literature. For a more detailed account of the review, we would direct readers to the full report from this project published on the NIHR Journals library (link provided in Methods section).

Influence of the medical hierarchy on prescribing 'decisions'

The literature describes hierarchies as a core and pervasive aspect of professional socialisation in medicine, with senior clinicians (e.g. Consultants) setting the norms about what is appropriate prescribing in practice (i.e. what is and is not acceptable). In the articles reviewed, doctors-in-training are presented as largely compliant with the behaviours considered legitimate by the formal prescribing hierarchy (medical 'chain of command') at any given instance (i.e. the 'prescribing etiquette'). Analysis of the literature suggests this compliance results primarily from fear of criticism and fear of individual responsibility for patients deteriorating. Doctors-in-training are also driven by the need to sustain positive relationships

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and manage the impressions of others, in the context of their seniors' role in evaluating their performance and influencing career progression. As described by relevant studies, they try to fit in with the teams they are working with by adopting an identity of a competent trainee (which often means '*doing as you are told'*). Findings related to the role of medical hierarchy on prescribing decisions are synthesised in *CMOCs 1* and *2* (the illustrative data excerpts used to develop and refine these CMOC 1 and 2 may be found in Supplementary data – Part 5 and a detailed example of how we developed a CMOC is illustrated in Supplementary data – Part 6): [27, 46-66]

CMOC1: In a context of learning through role-modelling within hierarchical relationships (C), junior doctors passively comply with the prescribing habits and norms set by their seniors (O), due to fear of criticism (M) and fear of individual responsibility for patients deteriorating (M).

CMOC2: In a context where career progression depends on hierarchical power relationships (C), junior doctors feel they have to preserve their reputation and position in the hierarchy (fitting-in) (M), by actively following the example of their seniors and avoiding conflict (O).

The literature discusses particular examples of how norms are set differently in different specialties. When rotating in different environments, doctors-in-training encounter a number of different 'rules' depending on the specialties, teams or seniors they are working with. In this respect, antimicrobial prescribing becomes situated - to respond to the norms and needs of particular situations, and relational - to respond to the requirements and norms of particular relationships within hierarchical and inter-professional modes of working (*CMOC3* in Supplementary data – Part 5).[27, 49, 50, 52-55, 60, 64, 67-76]

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According to the articles reviewed, perceptions of responsibility and accountability also play a role in influencing the extent to which doctors-in-training follow the norms set by the hierarchy. When trainees perceive that it is their seniors who have responsibility for patient outcomes, they tend to follow the practices indicated as legitimate by those seniors who have ultimate responsibility (*CMOC4* in Supplementary data – Part 5).[50, 57, 60, 63, 77, 78]

Influence of the hierarchy on balancing conflicting priorities and using sources of support

Role-modelling from senior to junior levels of the hierarchy extends to how conflicting goals should be prioritised (*CMOC5* in Supplementary data – Part 5). The way senior clinicians engage in decision making indicates to trainees how they should prioritise between more immediate, individual short-term goals of patient recovery (e.g. from possible sepsis) and long-term, collective goals of minimising antimicrobial resistance. In examples included in the literature, it is suggested that seniors also role-model how to find a balance between the need for antimicrobial prescribing against the risk of side effects (e.g. *Clostridium difficile* infection).[60, 61, 79]

In such a context of learning through implicit or explicit role-modelling within hierarchical relationships, junior doctors follow the example of seniors, not just in their prescribing decisions, but also in what they count as legitimate sources of support for making prescribing decisions (*CMOCs 6-8* in Supplementary data – Part 5).[27, 49, 53-56, 60, 61, 66, 70, 74, 76, 80-94] Data from included studies indicates that doctors-in-training will be more inclined to follow guidelines when this is clearly signalled as appropriate behaviour by the senior clinical staff they are accountable to. The primary influence behind guideline use seems to be whether these are adopted and perceived as credible by senior colleagues (*CMOC 9* in Supplementary data – Part 5 for factors influencing guideline credibility and use).[27, 53, 83, 95] The way seniors negotiate

patient expectations also seems to play an overriding role in how doctors-in-training decide to respond to perceived patient pressures to prescribe antibiotics (*CMOC10* in Supplementary data – Part 5).[53-55, 61, 96]

Besides the role of guidelines and patient expectations, the literature suggests that senior doctors also role-model how the opinions of other health professionals should be taken in account. By creating a legitimate role for other health professionals in the antimicrobial prescribing process, senior doctors signal to their trainees what is appropriate behaviour to follow, whose opinion counts, in what cases and to what extent (*CMOCs 11-12* in Supplementary data – Part 5).[28, 53, 71, 76, 97, 98] Some contexts are described in the literature where inter-professional (where relative status differences are more ambiguous) supervision and contribution may play an important role. For example, newly-qualified doctors may turn to the pharmacist as a source of support external to the medical hierarchy, as they will feel less fear of appearing ignorant or having negative repercussions (*CMOC13* in Supplementary data – Part 5).[27, 28, 47, 51, 53, 60, 61, 65, 70, 75, 77, 97, 99, 100]

Analysis of the data in the included studies shows role-modelling may result in positive learning, when (for example) senior doctors follow appropriate prescribing behaviours and clearly explain the rationale of their decisions (e.g. how these correspond to the evidence base or why they diverge based on specific patient needs). According to the literature, optimal role-modelling means explicitly setting the rules about how hierarchical relationships operate in different environments and how trainees should expect to be embedded within them (*CMOC14* in Supplementary data – Part 5).[28, 50, 53, 55, 61, 83, 97, 101-109] Conversely, role-modelling may result in the reinforcement of suboptimal prescribing habits and prescribing etiquette(s) if rules remain implicit or are only enforced through authority and the rationale is not clarified to facilitate learning (*CMOC15* in Supplementary data – Part 5).[27, 28, 50, 53-55, 64, 77, 84, 97, 109-113] Such hierarchical environments where the rationale for prescribing decisions is rarely discussed, are

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405 often perceived to contribute to a culture of using doctors-in-training to provide service rather
406 than prioritising their learning needs (*CMOC16* in Supplementary data – Part 5).[15, 63, 110, 111,
407 113-115]

408

409 ***Asking for advice and challenging decisions***

410 In hierarchical environments, rules on how to interact with other health care professionals and
411 on how to effectively apply knowledge in practice at different training levels often remain
412 implicit (or unspoken). As a result, doctors-in-training face difficulties making 'choices' and
413 navigating relationships with health professionals that could provide them with assistance
414 (*CMOC17* in Supplementary data – Part 5).[28, 63, 69, 71, 73, 77, 79, 83, 98-100, 102-104, 116-122]

415 Detailed analysis of the literature highlights how trainees make detailed judgments about: a)
416 *whether* or not it would be acceptable to ask for assistance when making certain antimicrobial
417 prescribing decisions, b) *what* types of topics would be acceptable to ask about, c) *who* they
418 should address their questions to, and d) *how* they should frame and communicate their
419 questions. Doctors-in-training make judgments on these points, depending on the condition of
420 the patient, whether they feel a case falls within their remit or knowledge, and depending on
421 what they think the consequences of seeking assistance from particular colleagues would be
422 (*CMOCs 18-20* in Supplementary data – Part 5).[28, 63, 69, 71, 73, 77, 79, 83, 98-100, 102-104, 116-122]

423 Similar dynamics seem to apply in cases where trainees consider challenging the decisions of
424 their seniors. The literature discusses how reluctance to challenge stems from the belief that it
425 is unlikely that the senior would change their decision, that any error would not be major
426 enough to result in direct patient harm and that it would be more appropriate for someone else
427 at a different position in the hierarchy to identify and intercept the error (*CMOCs 21-22* in
428 Supplementary data – Part 5).[27, 47, 50, 60, 64, 78, 103, 110, 115, 122-129] In contrast, where senior clinicians

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signal openness to receiving questions and set relevant norms of behaviour, they may increase trust in junior-senior relationships and allow doctors-in-training to feel more comfortable in raising questions (*CMOCs 23-24* in Supplementary data – Part 5).[50, 60, 78, 115, 123, 125, 127, 129, 130]

Yet, the literature suggests that even when seniors are perceived as approachable, some doctors-in-training still refrain from asking for help and/or advice, out of fear of upsetting established relationships and due to a perception that this will negatively impact on their reputation. This shows that collective hierarchical norms are often more powerful than norms or rules set by individual senior doctors (*CMOC25* in Supplementary data – Part 5)[100, 117] while discrepancies in perceptions of communication openness between hierarchical levels are prevalent (*CMOC26* in Supplementary data – Part 5).[63, 123, 131, 132]

Changing contexts

As training progresses, doctors become more comfortable negotiating the boundaries of responsibility, knowledge expected and its application in practice at different stages. Through professional socialisation in different environments they learn how to operate under different rules set by the local hierarchies. Their ability to ask questions and confidently argue alternative positions changes over time, as with increasing seniority they are expected to assume more autonomy and responsibility (*CMOCs 27-28* in Supplementary data – Part 5).[55, 57, 72, 76, 77, 100, 111, 115, 116, 129]

Figure 2 provides an overarching programme theory which consolidates the relationships between the 28 detailed explanations (i.e. CMOCs) emerging from the data, organised around the important outcomes identified.

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Figure 2: Overarching realist programme theory

Discussion

Summary of findings

The IMPACT review adds to a growing literature that acknowledges the importance of the wider context in which an intervention is implemented and attempts to explain how and why trainee prescribing practices differ under different circumstances. In doing this, the review does not aim to produce evidence about the relative advantage of different interventions. Given the complexity and clinical uncertainty inherent in antimicrobial prescribing, it is likely that a context-sensitive combination of top-down and bottom-up, multifaceted solutions and ongoing support will be required to improve practice.[133, 134] Rather, we looked at how interventions can be *tailored* effectively for doctors-in-training, taking in account the way trainees negotiate antibiotic prescribing in practice.

The overarching programme theory of the IMPACT review explains how and why doctors-in-training decide in certain contexts to passively comply or actively follow their senior prescribing habits, the way they take into account prescribing aids and consult other health professionals, along with how they negotiate patient expectations (the most common outcomes in the data). The programme theory also explains what drives reluctance or willingness to ask questions about antimicrobial prescribing or to challenge the decisions made by seniors, as well as how this changes as training progresses. As discussed in the literature reviewed, these outcomes result from complex inter-relationships between the contexts in which doctors-in-training practice (i.e. hierarchical relationships, with powerful prescribing norms, where there is little clarity around roles and responsibilities, and knowledge expectations and how to apply knowledge in practice remain implicit) and the mechanisms triggered in these contexts (i.e.

fear of criticism, fear of individual responsibility, need to manage one's own reputation and position in the team, and to appear as competent).

Comparison with existing literature

Despite recognition of the significant influence of social norms in trainee prescribing, there is still emphasis on purely knowledge- or skills-based interventions.[56, 59, 61, 66, 72, 80, 85, 87, 88, 135-139] This emphasis is underpinned by an assumption that, having identified misplaced beliefs and erroneous prescribing decisions, one can improve the knowledge 'deficit' by delivering targeted education. However, our findings show that doctors-in-training often struggle, not just because of knowledge 'deficits', but because they have difficulty applying their knowledge in practice. When education and feedback interventions are disjointed from how prescribing decisions are made in the workplace, they are less likely to result in meaningful and sustainable change. Therefore, there is a need to incorporate an understanding of local prescribing norms and power dynamics in the design and delivery of context-sensitive education and feedback programmes, including training on teamwork, communication, error awareness and management that addresses the influence of hierarchical teams.[54, 85, 105, 140, 141]

Although doctor leadership has been widely discussed, promoted and encouraged in health care globally (and especially in the UK NHS), little attention has been paid to how 'leading from beneath' – building leadership capabilities in the context of a hierarchical setting – could contribute to more appropriate antimicrobial prescribing decisions.[62, 142-144] It may also be relevant to consider antimicrobial prescribing competencies for senior clinicians (or for more senior trainees) including deliberately role-modelling appropriate prescribing and facilitating assistance from antimicrobial specialists, both within and across specialties and occupational groups. Our findings indicate that accepting antimicrobial prescribing more widely as 'a

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specialised act' could significantly legitimise the input of antimicrobial specialists and foster collaborative working.[60, 136, 145, 146] Without senior involvement, however, it would be difficult to set an example for junior doctors.

Recommendations for policy and practice

Based on the findings of the review, we have focused our recommendations on six key areas for consideration when designing and implementing antimicrobial prescribing interventions for doctors-in-training (*Figure 3*). These recommendations have been developed so that they are transferable and generic enough to allow local tailoring of different types of interventions for different environments.

Figure 3: Areas to consider when designing or implementing antimicrobial prescribing interventions that include or target doctors-in-training.

1. **Making AMR everyone's 'business'**: Given the importance of hierarchical dynamics in influencing prescribing decisions, it would not be adequate to implement interventions that target one specific group of prescribers, especially when this group is considered to have a lower status in the hierarchy. A wider cultural shift is necessary across all professional groups and levels of training.
2. **Specifying what trainees at different levels of training are responsible for**: Having commonly agreed roles and responsibilities for appropriate antimicrobial prescribing (e.g. reviewing antibiotics prescribed), could mean doctors-in-training would be empowered to take initiative and address how treatment may be optimised for each patient.
3. **Clarifying knowledge, skills and capabilities needed to fulfil responsibilities**: In addition to setting particular roles and responsibilities, it would also be important to ensure

appropriate knowledge and skills (e.g. in the form of training or prescribing resources) are in place, and there is scope to apply this knowledge in practice, so trainees can perform their roles effectively.

4. **Providing clear processes for seeking advice and support**: Developing explicit processes for seeking assistance, i.e. commonly accepted procedures for seeking help from particular colleagues or seniors (e.g. explicit rules on who should they call and when), would facilitate decision-making for doctors-in-training and would reduce barriers to seeking advice.
5. **Ensuring changes are endorsed and reinforced by seniors in the workplace**: As senior doctors play a significant role in setting prescribing norms and influencing junior clinicians, any interventions that do not match accepted norms may not translate to better practice. Hierarchical relationships can play a constructive role when used to role-model and reinforce appropriate prescribing behaviours.
6. **Enabling adequate trust so clinicians will ask questions and challenge**: Being explicit about appropriate knowledge levels, skills and capabilities for different stages in training (see point 3 above) would be a necessary first step in building explicit boundaries around what questions are considered legitimate (what is it that one is expected to know and what is not). This may not be sufficient on its own, however, as there is a need to actively develop conditions in which doctors-in-training will feel safe to ask questions, feed back to their clinical teams and challenge decisions made by others.

To extend the reach of our work, as advised by our stakeholder group, we have also developed an animation video that can be used as part of medical training to trigger reflection and discussion on antimicrobial prescribing (https://vimeo.com/190717025).

Strengths and limitations

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To conduct this review we have systematically applied rigorous methodological guidance for realist reviews as described in the RAMESES quality standards.[147] Use of a realist approach has allowed us to place emphasis on how contexts influence outcomes and to focus on identifying generative mechanisms, thereby producing findings that are transferable across different types of interventions and across settings. This is reflected in the project outputs (animation and infographic) which have wider applicability.

By definition, however, evidence syntheses are reliant on the evidence that is available. We found that interventions were often not described in enough detail to be able to draw conclusions on how their different aspects had resulted in improved prescribing for doctors-in-training. In some of the CMOCs, lack of adequately detailed data in included papers means we have not been able to fully determine some of the fine grained relationships between contexts, mechanisms and outcome. In addition, the majority of the articles were set in secondary care, rather than general practice. This remains a limitation of the study, although our interpretations of the data attempted to account for differences between settings.

Conclusions

Few interventions to change the antimicrobial prescribing practice of doctors-in-training are designed and implemented in ways that pay adequate attention to the influence of contexts and the ways these change during clinical training. There is little scope for improvement if the contexts in which antimicrobial prescribing is nested remain unacknowledged. This realist review contributes to our understanding of how antimicrobial prescribing interventions can be better embedded in the hierarchical and inter-professional dynamics of different healthcare settings. Recommendations emerging from this work can be transferable across settings to better support trainees with their antimicrobial prescribing practice. Together with our

stakeholder group, we have also developed dissemination materials to enable optimal tailoring, design and implementation of antimicrobial prescribing interventions targeted at doctors-in-training. Further research could focus on how the implications identified in this review can be addressed in practice.

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Transparency declarations

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Authors' contributions

NB, KM, MP and GW developed the research project. SB developed and conducted the search strategies. MP facilitated patient and public involvement for the review. NB, KM, MP, GW shaped the formal search strategies, provided content and theoretical literature, methodological expertise, and contributed to the development and refinement of programme theory. CP contributed to the formal search strategies, carried out screening and article selection processes, applied a realist logic of analysis to the data, identified theoretical ideas for the programme theory, facilitated the stakeholder meetings, drafted the project report and co-authored this paper. GW was the principal investigator, applied a realist logic of analysis to the data, carried out consistency checks and co-authored this paper. All authors read, reviewed and approved the final manuscript.

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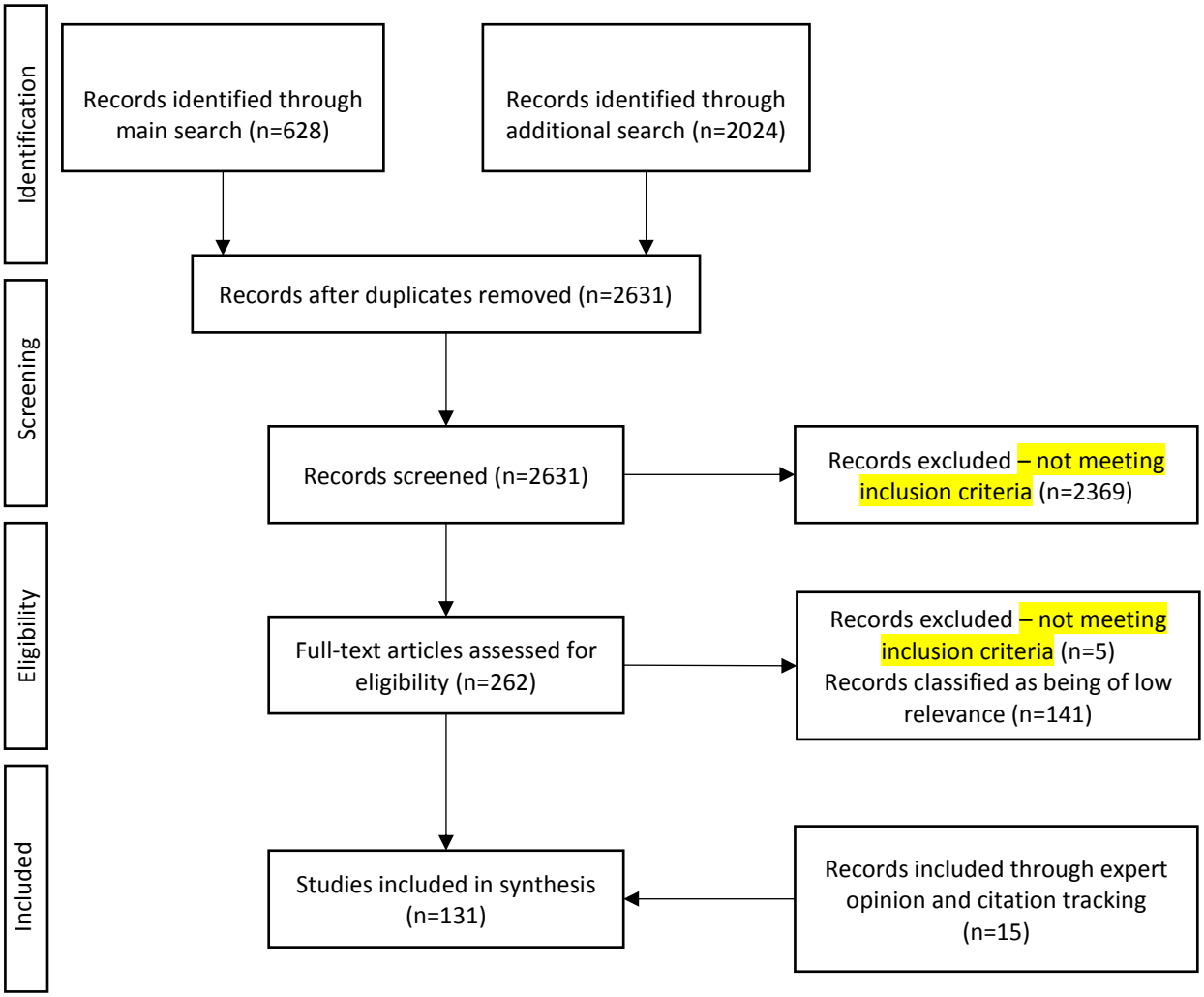
975 **Figures**

976



977 Figure 1: PRISMA diagram

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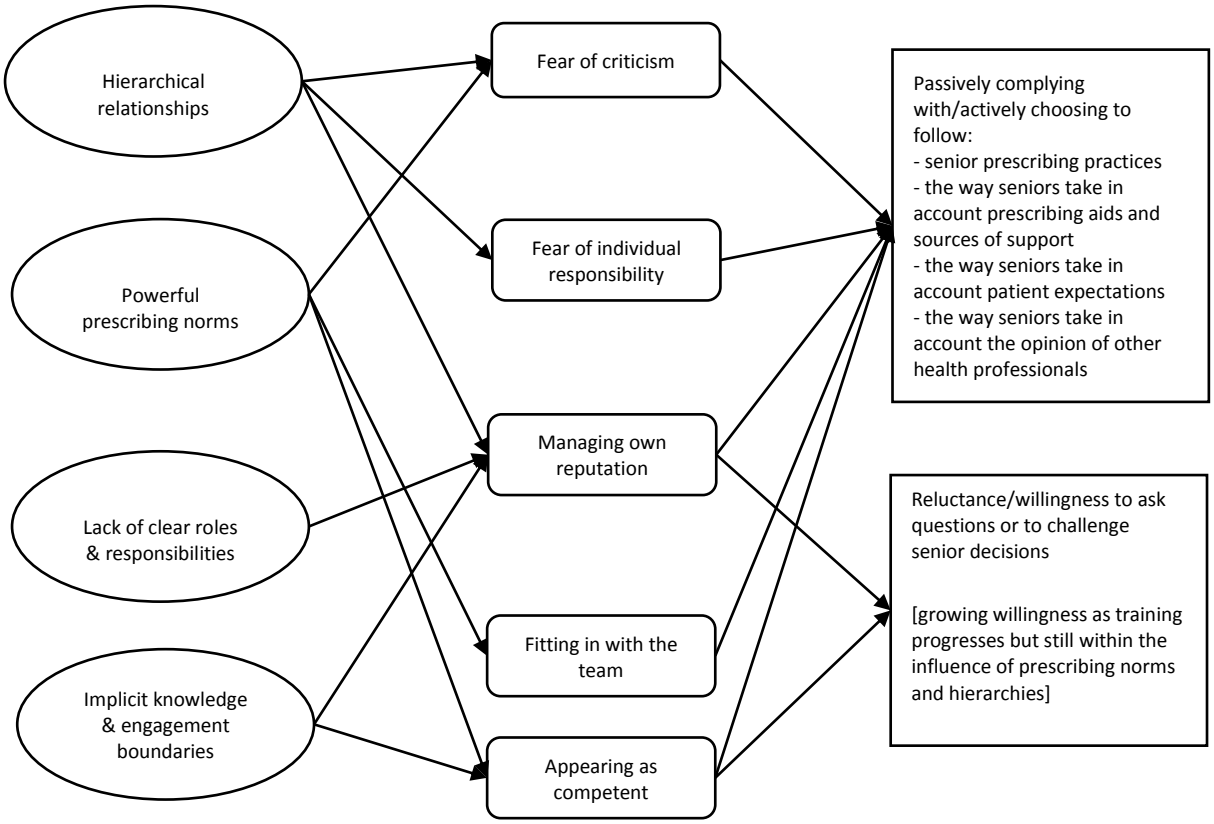

Figure 2: Overarching realist programme theory

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984 Figure 3: Areas to consider when designing or implementing antimicrobial prescribing

985 interventions that include or target doctors-in-training.

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